Alberta Energy Regulator

Directive 083: Hydraulic Fracturing – Subsurface Integrity

May 21, 2013

Effective June 17, 2013, the Energy Resources Conservation Board (ERCB) has been succeeded by the Alberta Energy Regulator (AER).

As part of this succession, the title pages of all existing ERCB directives now carry the new AER logo. However, no other changes have been made to the directives, and they continue to have references to the ERCB. As new editions of the directives are issued, these references will be changed.

Some phone numbers in the directives may no longer be valid. Contact AER Inquiries at 1-855-297-8311 or inquiries@aer.ca.

ERCB Energy Resources Conservation Board

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Directive 083

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Hydraulic Fracturing – Subsurface Integrity

The Energy Resources Conservation Board (ERCB/Board) has approved this directive on May 21, 2013.

<original signed by>

Brad McManus
Acting Chair

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1 Introduction

1.1 Purpose of This Directive

This directive sets out the Energy Resources Conservation Board's (ERCB) requirements for managing subsurface integrity associated with hydraulic fracturing subsurface operations. This directive does not apply to thermal wells.

These requirements are intended to

- prevent the loss of well integrity at a subject well (a well at which a licensee proposes to conduct hydraulic fracturing operations),
- reduce the likelihood of unintentional interwellbore communication between a subject well and an offset well,[1]
- manage well control at an offset well in the event of interwellbore communication with a subject well,
- prevent adverse effects to nonsaline aquifers,
- prevent impacts to water wells, and
- prevent surface impacts.

For other requirements not dealt with in this directive, refer to appendix 2.

This directive rescinds *Directive 027: Shallow Fracturing Operations – Restricted Operations* and supersedes *Bulletin 2012-02: Hydraulic Fracturing: Interwellbore Communication between Energy Wells*.

This directive includes

- requirements to prevent the loss of well integrity at a subject well (section 2),
- requirements for licensees to assess, plan for, and mitigate the risks of interwellbore communication with offset wells (section 3),
- requirements to notify licensees of at-risk offset wells related to hydraulic fracturing operations (section 3),
- requirements to protect nonsaline aquifers from hydraulic fracturing operations conducted at depths less than 100 metres (m) below the base of groundwater protection (BGWP) (section 4),
- increased vertical depth restriction for hydraulic fracturing operations near water wells (section 5),

1 An offset well includes any well that has been designated by the Board as an orphan well pursuant to section 70(2)(a) of the *Oil and Gas Conservation Act*

- increased vertical depth restriction for hydraulic fracturing operations near the top of the bedrock surface (section 6),
- pumping-volume restrictions and provisions to setback distances for nitrogen fracturing operations for coalbed methane (section 7), and
- requirements to notify the ERCB about hydraulic fracturing operations (section 8).

1.2 Implementation Date for Directive 083 Requirements

1) The requirements of this directive are effective August 21, 2013 (three months from the date of publication). Licensees are to continue to follow the applicable requirements in both *Directive 027* and *Bulletin 2012-02* until August 21, 2013.

1.3 Compliance Assurance

The term "must" indicates ERCB requirements for which compliance is required and is subject to ERCB enforcement. The terms "recommends" or "expects" indicate recommended practices and are not subject to enforcement action.

Noncompliance with any requirement may result in licensees receiving a response in accordance with *Directive 019: Compliance Assurance*. A list of noncompliance events is available from the ERCB website, www.ercb.ca.

Licensees are responsible for compliance with ERCB requirements. If licensees identify a noncompliance, it should inform the ERCB of the noncompliance for consideration under the ERCB Voluntary Self-Disclosure policy set out in *Directive 019*.

For the purposes of this directive, the term "licensees" is used to designate the responsible duty holder (e.g., licensee, operator, company, applicant, approval holder, permit holder) as specified in legislation, and refers to subject well licensees unless otherwise stated.

In its assessment of licensees' compliance with the requirements of this directive, the ERCB may at any time request licensees to produce those documents, records, or plans required to be completed by this directive, and licensees must provide them to the ERCB. If the ERCB determines that the documentation is incomplete, insufficient, or that additional documentation is needed to support licensees' compliance with the regulatory objectives in this directive, licensees may be required to provide additional documentation prior to conducting its hydraulic fracturing operation. The ERCB recommends that all documentation be kept on file for the life of the well.

1.4 Directive 083 Help

If you have a specific question not covered in this directive, contact the ERCB's Well Operations Section:

Phone: 403-297-5290
Fax: 403-297-2691
E-Mail: WellOperations@ercb.ca

2 Well Integrity – Subject Well

2.1 Issue

During hydraulic fracturing operations, subject wells can incur significant stresses, which may lead to a loss of well integrity. A loss of well integrity may result in subsurface impacts or result in a release of fluids to the surface, placing the public and the environment at risk.

2.2 Regulatory Objective

To prevent the loss of well integrity at a subject well.

2.3 Requirements

2.3.1 General

2) Licensees must design, construct, and operate its well to provide well integrity during hydraulic fracturing operations.

3) Licensees must obtain ERCB approval if using a barrier system other than a single- or dual-barrier system as described below.

Licensees are expected to manage well integrity throughout the life of the well, from construction to post abandonment.

2.3.2 Dual-barrier System

4) If a dual-barrier system (see figure 1) is used, it must consist of

a) a primary barrier system capable of containing and isolating the fracture fluids,

b) a secondary barrier system capable of providing well control in the event of a failure of the primary barrier, and

c) a monitoring system to detect and allow for a response to a primary barrier failure.

5) To be classified as a dual-barrier system, the cement of the primary barrier system must not extend above the base of the overlying porous interval.

2.3.3 Single-barrier System

The ERCB expects licensees to apply increased diligence in designing a single-barrier system (see figure 2).

When using a single-barrier system, surface casing must be set in accordance with the current requirements of *Directive 008: Surface Casing Depth Requirements*.

6) If surface casing is not set to the BGWP, licensees must

a) not use hydraulic fracturing fluids that may cause an adverse effect on nonsaline aquifers and

b) cement the next casing string to surface.

7) If a single-barrier system is used, licensees must

a) document the load capacity and safety factors used in the design of its casing relative to the loads and the well environment that the casing will be exposed to,

b) document the adjusted maximum pressure,

c) use an operating practice, such as the *Primary and Remedial Cementing Guidelines* (Drilling and Completions Committee) or a technically equivalent standard, when planning and executing its cementing program,

d) be able to demonstrate integrity of both casing and cement prior to initial fracture operations,

e) be able to demonstrate integrity of casing during fracture operations,

f) be able to demonstrate integrity of casing with final completion operations or within 90 days of the fracture operation, and

g) conduct a surface casing vent flow / gas migration test (as per *Interim Directive 2003-01: Isolation Packer Testing, Reporting, and Repair Requirements; Surface Casing Vent Flow/Gas Migration Testing, Reporting, and Repair Requirements; Casing Failure Reporting and Repair Requirements*) or a surface casing annulus flow test (as per the attachment to *Bulletin 2011-35: Surface Casing Vent Requirements for Wells*)

- prior to initial fracturing operations and
- between 60 and 90 days after completing fracturing operations.

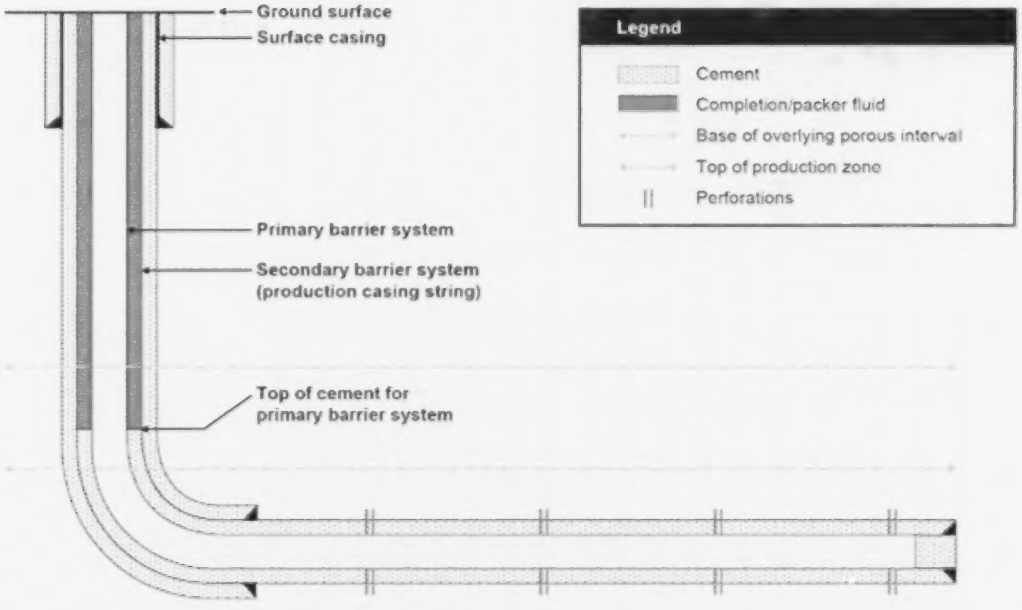

Figure 1. Example of a simplified dual-barrier system.

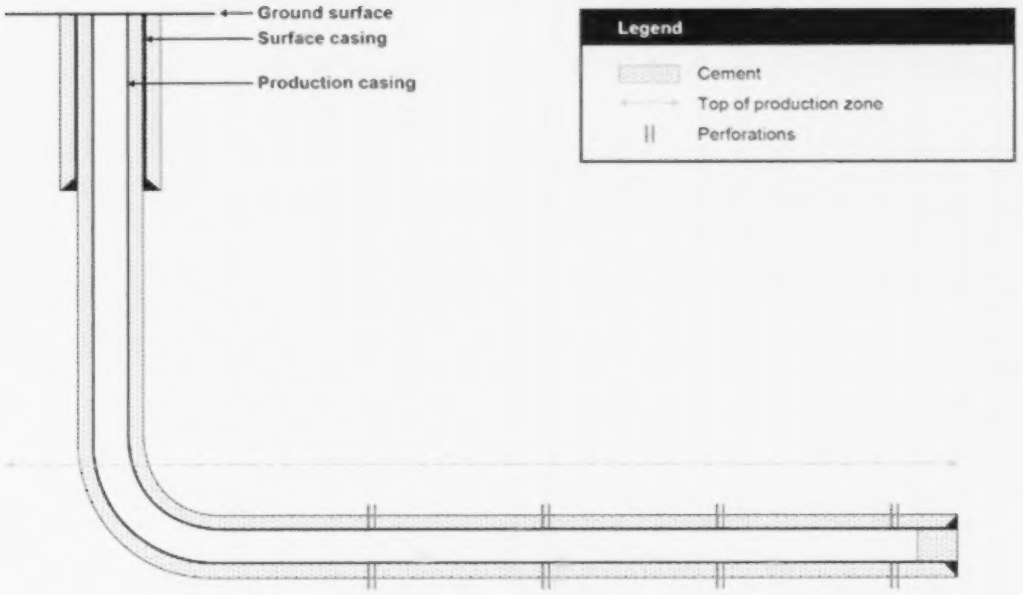

Figure 2. Example of a single-barrier system.

3 Interwellbore Communication

3.1 Issue

Interwellbore communication occurs when a communication pathway has been established between a subject well and an offset well. A communication pathway may cause a well-control event at an offset well, which may result in subsurface impacts or a release of fluids to the surface, placing the public and the environment at risk.

3.2 Regulatory Objective

To reduce the likelihood of unintentional interwellbore communication between a subject well and an offset well.

To manage well control at an offset well in the event of interwellbore communication with a subject well.

3.3 Requirements

3.3.1 General

8) Licensees must manage the risks of interwellbore communication between a subject well and an offset well.

3.3.2 Hydraulic Fracturing Risk Planning

9) Licensees must have a documented hydraulic fracturing program.

10) The hydraulic fracturing program must include the following elements:

   a) determination of a fracture planning zone (FPZ),

   b) identification of all offset wells within the FPZ,

   c) an assessment of well integrity for each offset well,

   d) a risk assessment for each offset well, using a methodology such as that described in *Interim Industry Recommended Practice 24: Fracture Stimulation: Interwellbore Communication* (*IRP 24*) (Drilling and Completions Committee),

   e) determination of at-risk offset wells within the FPZ,

   f) identification and assessment of special-consideration wells for possible inclusion in the well control plan, and

   g) identification of energizing gas(es) used in fracture fluids.

11) Licensees must maintain a copy of its hydraulic fracturing program at the subject well site for the duration of the operation.

The use of high vapour pressure hydrocarbons requires prior approval by the ERCB pursuant to section 8.110 (3) of the *Oil and Gas Conservation Regulations*.

Licensees should be aware of any subsurface features such as those described in *IRP 24* Hazard Register.

3.3.3 At-risk Offset Well Control Plans

12) Licensees must have a documented well control plan for each at-risk offset well that includes

   a) the method(s) of detection of interwellbore communication,

   b) how information will be relayed from an at-risk offset well back to the hydraulic fracturing operations should an interwellbore communication event occur,

   c) the adjusted maximum pressure for each at-risk offset well, and

   d) how the licensee will ensure well control at each at-risk offset well.

13) Licensees must maintain a copy of its at-risk offset well control plan at the subject well site for the duration of the hydraulic fracturing operation.

3.3.4 Subject Well / At-risk Offset Well Licensee Engagement[2]

14) Licensees must notify licensees of at-risk offset wells of its planned hydraulic fracturing program.

   Upon notification of a planned hydraulic fracturing program, licensees of at-risk offset

[2] Within this section, if an at-risk offset well is an orphan well, "licensee" includes the Orphan Well Association.

wells are expected to engage and work cooperatively with licensees of subject wells in the development of well control plans.

15) Licensees must engage licensees of at-risk offset wells and make all reasonable efforts to develop mutually acceptable well control plans.

Licensees of both offset and subject wells are responsible for maintaining control of its licensed wells at all times.

16) If the at-risk offset well does not have an active licensee, and it is not an orphan well, licensees must contact the appropriate ERCB field centre.

17) Upon becoming aware of any communication event with an offset well, licensees must immediately notify the licensee of the offset well.

Additional ERCB notification requirements are found in section 8.1.

4 Nonsaline Aquifer Protection

4.1 Issue

Communication between the subject well and a nonsaline aquifer as a result of hydraulic fracturing operations may cause adverse effects.

4.2 Regulatory Objective

To prevent adverse effects to nonsaline aquifers.

4.3 Requirements

4.3.1 General

18) Licensees' hydraulic fracturing operations must not have an adverse effect on a nonsaline aquifer.

4.3.2 Nonsaline Aquifer Risk Assessment

19) A risk assessment must be prepared if conducting hydraulic fracturing operations above, or within 100 m below, the BGWP.

20) Licensees' risk assessment must include the following:

a) an evaluation of the potential for direct fracture communication from the subject well to a nonsaline aquifer,

b) the true vertical depth (TVD) of the top and base of any nonsaline aquifers above the BGWP,

c) the TVD of the fracture interval(s) within the wellbore,

d) the modelled vertical fracture distance (i.e., vertical half length),

e) the minimum distance between vertical fracture propagation and the adjacent nonsaline aquifers along the entire fracture interval,

f) documentation of the procedure used to determine whether or not fracture fluid components may cause an adverse effect on nonsaline aquifers,

g) any geological feature or other pathways that may allow or facilitate communication to a nonsaline aquifer, and

h) mitigation measures to minimize the risk of adverse effects on nonsaline aquifers.

21) If the modelled vertical fracture distance multiplied by a factor of two is within, or would extend above, the BGWP, licensees must not use hydraulic fracturing fluids that may cause adverse effect on nonsaline aquifers.

5 Hydraulic Fracturing Near Water Wells

5.1 Issue

Communication between the subject well and water wells as a result of hydraulic fracturing operations may cause adverse effects.

5.2 Regulatory Objective

To prevent impacts to water wells.

5.3 Requirements

22) Licensees' hydraulic fracturing operations must not have an adverse effect on the water well's water quality or quantity.

23) Licensees must not initiate hydraulic fracturing operations within a zone that extends 200 m horizontally from the surface location of a water well and 100 m vertically from the total depth of the water well (see figure 3), except when using nitrogen as the fracturing fluid for coalbed methane completions (see section 7).

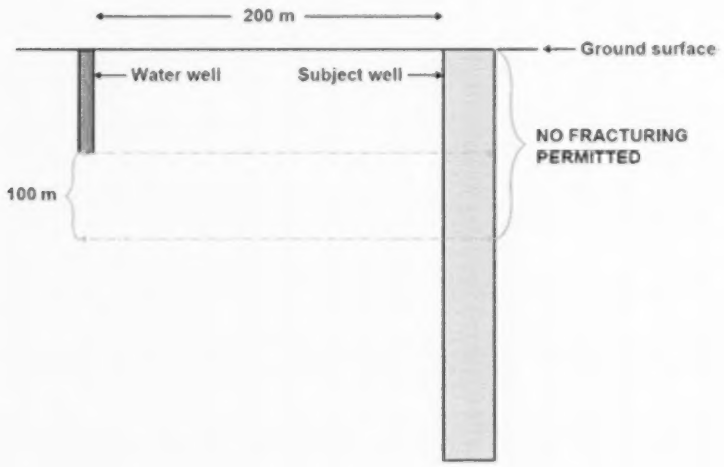

Figure 3. Hydraulic fracturing near water wells.

6 Hydraulic Fracturing Near Top of Bedrock

6.1 Issue

Fracture propagation during hydraulic fracturing operations may result in a release of fluids to the surface, placing the public and the environment at risk.

6.2 Regulatory Objective

To prevent surface impacts.

6.3 Requirements

24) Licensees' hydraulic fracturing operations must not cause surface impacts.

25) Licensees must not hydraulically fracture within 100 vertical m of the top of the bedrock surface (see figure 4), except when using nitrogen as the fracturing fluid for coalbed methane completions (see section 7).

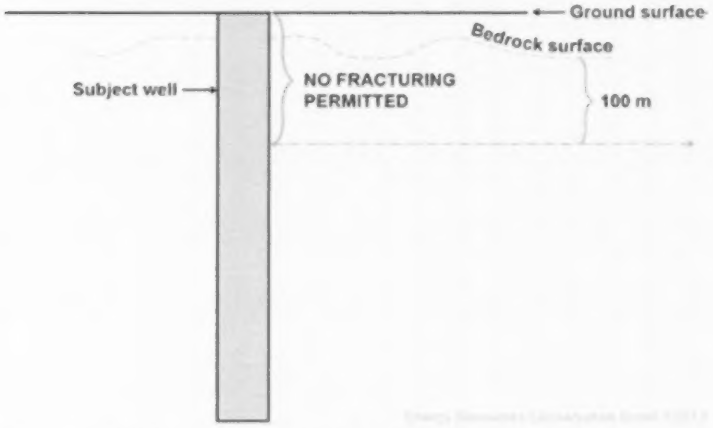

Figure 4. Hydraulic fracturing near top of bedrock.

7 Special Provisions for Coalbed Methane Fracturing

The requirements below are derived from an independent study with respect to using *nitrogen* as the fracturing fluid for coalbed methane completions.[3]

7.1 Coalbed Methane Fracturing Near Water Wells

26) Licensees must not initiate nitrogen fracturing operations within a zone that extends 200 m horizontally from the surface location of a water well to 50 m vertically from the total depth of the water well.

7.2 Coalbed Methane Fracturing Near Top of Bedrock

27) Licensees must not initiate nitrogen fracturing operations within 50 vertical m of the top of the bedrock surface.

[3] The report, *Shallow Nitrogen Fracturing Dimensions and Groundwater Protection*, outlining the findings of the study can be found on the landing page for *Directive 027: Shallow Fracturing Operations-Restricted Operations* on the ERCB website, www.ercb.ca.

7.3 Nitrogen Pumping Volume Limitations in Coals

28) Licensees must not use more than 15 000 standard cubic metres of nitrogen per vertical metre of coal.

8 ERCB Notification Requirements

29) Licensees must notify the ERCB a minimum of five days prior to the pressure test of surface equipment for hydraulic fracturing operations as per the Hydraulic Fracturing Notification Submission procedure found on the ERCB website at www.ercb.ca.

Notification is for one well licence or for a pad (multi-well) with continuous hydraulic fracturing operations.

30) If an operation is demobilized and remobilized at a later date, licensees must re-notify the ERCB via the Hydraulic Fracturing Notification Submission procedure a minimum of five days prior to the pressure test of surface equipment for hydraulic fracturing operations.

Notification is for one well licence or for a pad (multi-well) with continuous hydraulic fracturing operations.

31) Licensees must immediately notify the appropriate ERCB field centre if well integrity fails.

32) Licensees of the subject well must immediately notify the appropriate ERCB field centre upon becoming aware of any communication event with an offset well, a nonsaline aquifer, or a water well.

9 Continual Improvement

It is recommended that all licensees continually improve the planning and execution of its hydraulic fracturing operations by evaluating the effectiveness of its operations in meeting the regulatory objectives of this directive and by revising the planning and execution of its subsequent hydraulic fracturing operations accordingly.

Licensees are encouraged to document its continual improvement process using a procedure such as that described in *IRP 24*.

Appendix 1 Definitions of Terms as used in This Directive

Adjusted maximum pressure	Operating pressure limits at the subject well and the offset wells, including a safety margin that will not be exceeded.
Adverse effect	As defined in the *Environmental Protection and Enhancement Act*.
At-risk offset well	An offset well that may be adversely affected by a hydraulic fracturing operation.
Barrier	Individual components that collectively make up a barrier system.
Base of groundwater protection (BGWP)	A modelled depth at which saline groundwater is likely to occur. It is calculated as the base of the deepest protected (nonsaline groundwater-bearing) formation plus a 15 m buffer.
Bedrock	Consolidated rock underlying unconsolidated glacial or drift material.
Dual-barrier system	A well system designed for hydraulic fracturing operations made up of both primary and secondary barrier systems.
Energizing gas	A gas used to improve the effectiveness of the hydraulic fracture.
Fracture planning zone (FPZ)	An area that may be impacted by hydraulic fracturing operations.
High vapour pressure hydrocarbon	As per section 8.110(1) of the *Oil and Gas Conservation Regulations*.
Nonsaline aquifer	An aquifer above the BGWP that contains water with a total dissolved solids content of less than or equal to 4000 milligrams per litre.
Offset well	Any well that is within the FPZ of a subject well, excluding water wells.
Orphan well	A well that has been designated by the Board as an orphan well pursuant to section 70(2)(a) of the *Oil and Gas Conservation Act*.
Primary barrier system	A well system designed to contain and isolate fracture fluids within the well.
Risk assessment	Systematic analysis of the risks from activities and a rational evaluation of their significance by comparison against predetermined standards, target risk levels, or other risk criteria.
Secondary barrier system	The backup well system that provides well control in the event of a failure of the primary barrier system.
Single-barrier system	A well system designed for hydraulic fracturing operations comprised of a primary barrier system only.
Special-consideration well	A well beyond the FPZ that may have characteristics of unique concern which justifies further scrutiny.
Subject well	A well at which a licensee proposes to conduct hydraulic fracturing operations.

Thermal well	A well that is completed in a reservoir that is, was, or has the potential to be artificially heated.
Water well	A well with the primary purpose of nonsaline groundwater production.
Well control event	A flow of wellbore fluids in the subsurface from one formation to another formation, a flow of wellbore fluids at surface that can be controlled by existing wellhead or blowout prevention equipment, or a blowout.
Well integrity	Prevention of the escape of fluids (i.e., liquids or gases) to subsurface formations or surface.

Appendix 2 Additional ERCB Directives

Other aspects that have not been dealt with under this directive, such as the design and operation of surface facilities, subsurface well design, waste management, well licensing, and emergency preparedness, are covered under other ERCB directives, including the following:

- *Directive 008: Surface Casing Depth Requirements*
- *Directive 009: Casing Cementing Minimum Requirements*
- *Directive 010: Minimum Casing Design Requirements*
- *Directive 019: Compliance Assurance*
- *Directive 051: Injection and Disposal Wells – Well Classifications, Completions, Logging, and Testing Requirements*
- *Directive 055: Storage Requirements for the Upstream Petroleum Industry*
- *Directive 056: Energy Development Applications and Schedules*
- *Directive 058: Oilfield Waste Management Requirements for the Upstream Petroleum Industry*
- *Directive 059: Well Drilling and Completion Data Filing Requirements*
- *Directive 060: Upstream Petroleum Industry Flaring, Incinerating, and Venting*
- *Directive 071: Emergency Preparedness and Response Requirements for the Petroleum Industry*